may also include other elements, such as, but not limited to, halogens, metallic elements, nitrogen, oxygen, and/or sulfur. Hydrocarbons may be, but are not limited to, kerogen, bitumen, pyrobitumen, and oils. Hydrocarbons may be located within or adjacent to mineral matrices within the earth. Matrices may include, but are not limited to, sedimentary rock, sands, silicilytes, carbonates, diatomites, and other porous media.

On page 64, please delete the paragraph beginning on line 11, and substitute therefor:

As shown in FIG. 3, in addition to heat sources 100, one or more production wells 104 will typically be disposed within the portion of the coal formation. Formation fluids may be produced through production well 104. Production well 104 may also include a heat source. In this manner, the formation fluids may be maintained at a selected temperature throughout production, thereby allowing more or all of the formation fluids to be produced as vapors. Therefore high temperature pumping of liquids from the production well may be reduced or substantially eliminated, which in turn decreases production costs. Providing heating at or through the production well tends to: (1) inhibit condensation and/or refluxing of production fluid when such production fluid is moving in the production well proximate to the overburden, (2) increase heat input into the formation, and/or (3) increase formation permeability at or proximate the production well.

In the Claims:

Please cancel claims 745-784 and 5399 without prejudice. (Claim 5399, dependent on claim 782, was submitted with Preliminary Amendment mailed on September 29, 2001.)

Listed below is a clean copy of amended claims. A marked-up copy indicating the amended sections of the claims is provided in an accompanying document.

5331. (amended) A method of treating a hydrocarbon containing formation in situ, comprising:
providing heat from one or more heaters to at least a portion of the formation;

allowing the heat to transfer from the one or more heaters to a part of the formation;

controlling a pressure and a temperature within at least a majority of the part of the formation, wherein the pressure is controlled as a function of temperature, or the temperature is controlled as a function of pressure; and

producing a mixture from the formation.

532. (amended) The method of claim 531, wherein the one or more heaters comprise at least two heaters, and wherein superposition of heat from at least the two heaters pyrolyzes at least some hydrocarbons within the part of the formation.

533. (amended) The method of claim 531, further comprising controlling formation conditions, wherein controlling formation conditions comprises maintaining a temperature within the part of the formation within a pyrolysis temperature range from about 270 °C to about 400 °C.

534. (amended) The method of claim 531, wherein at least one of the one or more heaters comprises an electrical heater.

535. (amended) The method of claim 531, wherein at least one of the one or more heaters comprises a surface burner.

536. (amended) The method of claim 531, wherein at least one of the one or more heaters comprises a flameless distributed combustor.

537. (amended) The method of claim 531, wherein at least one of the one or more heaters comprises a natural distributed combustor.

538. (amended) The method of claim 531, further comprising controlling the heat such that an average heating rate of the part of the formation is less than about 1 °C per day in a pyrolysis temperature range from about 270 °C to about 400 °C.

Sub D27

539. (amended) The method of claim 531, wherein providing heat from the one or more heaters to at least the portion of the formation comprises:

heating a selected volume (V) of the hydrocarbon containing formation from the one or more heaters, wherein the formation has an average heat capacity (Cv), and wherein the heating pyrolyzes at least some hydrocarbons within the selected volume of the formation; and

C3

wherein heating energy/day (Pwr) provided to the selected volume is equal to or less than $h*V*C_v*\rho_B$, wherein ρ_B is formation bulk density, and wherein an average heating rate (h) of the selected volume is about 10 °C/day.

Sub D3

C4

541. (amended) The method of claim 531, wherein providing heat from the one or more heaters comprises heating the part of the formation such that a thermal conductivity of at least a portion of the part of the formation is greater than about 0.5 W/(m °C).

Sub D4

C5

554. (amended) The method of claim 531, wherein the produced mixture comprises a non-condensable component, wherein the non-condensable component comprises molecular hydrogen, wherein the molecular hydrogen is greater than about 10 % by volume of the non-condensable component, and wherein the molecular hydrogen is less than about 80 % by volume of the non-condensable component at 25 °C and one atmosphere absolute pressure.

Sub D5

C6

561. (amended) The method of claim 531, further comprising controlling formation wherein controlling formation conditions comprises recirculating a portion of hydrogen from the mixture into the formation.

562. (amended) The method of claim 531, further comprising:

providing hydrogen (H_2) to the part of the formation to hydrogenate hydrocarbons within the part of the formation; and

heating a portion of the part of the formation with heat from hydrogenation.

Sub D7

564. (amended) The method of claim 531, wherein allowing the heat to transfer comprises

SUB D7 increasing a permeability of a majority of the part of the formation to greater than about 100 millidarcy.

C7 565. (amended) The method of claim 531, wherein allowing the heat to transfer comprises substantially uniformly increasing a permeability of a majority of the part of the formation.

SUB F7 567. (amended) The method of claim 531, wherein producing the mixture comprises producing the mixture in a production well, and wherein at least about 7 heaters are disposed in the formation for each production well.

SUB D8 568. (amended) The method of claim 531, further comprising providing heat from three or more heaters to at least a portion of the formation, wherein three or more of the heaters are

C8 located in the formation in a unit of heaters, and wherein the unit of heaters comprises a triangular pattern.

569. (amended) The method of claim 531, further comprising providing heat from three or more heaters to at least a portion of the formation, wherein three or more of the heaters are located in the formation in a unit of heaters, wherein the unit of heaters comprises a triangular pattern, and wherein a plurality of the units are repeated over an area of the formation to form a repetitive pattern of units.

570. (amended) A method of treating a hydrocarbon containing formation in situ, comprising:

providing heat from one or more heaters to at least a portion of the formation;

allowing the heat to transfer from the one or more heaters to a part of the formation to raise an average temperature within the part of the formation to, or above, a temperature that will pyrolyze hydrocarbons within the part of the formation;

producing a mixture from the formation; and

controlling API gravity of the produced mixture to be greater than about 25 degrees API by controlling average pressure and average temperature in the part of the formation such that the average pressure in the part of the formation is greater than the pressure (p) set forth in the

Sub D8 ~~following equation for an assessed average temperature (T) in the part of the formation:~~

$$p = e^{[-44000/T + 67]}$$

C8 where p is measured in psia and T is measured in Kelvin.

Sub D9 ~~573. (amended) The method of claim 570, wherein the one or more heaters comprise at least~~ two heaters, and wherein superposition of heat from at least the two heaters pyrolyzes at least some hydrocarbons within the part of the formation.

574. (amended) The method of claim 570, wherein controlling the average temperature comprises maintaining a temperature in the part of the formation within a pyrolysis temperature range from about 270 °C to about 400 °C.

C9

575. (amended) The method of claim 570, wherein at least one of the one or more heaters comprises an electrical heater.

576. (amended) The method of claim 570, wherein at least one of the one or more heaters comprises a surface burner.

577. (amended) The method of claim 570, wherein at least one of the one or more heaters comprises a flameless distributed combustor.

578. (amended) The method of claim 570, wherein at least one of the one or more heaters comprises a natural distributed combustor.

579. (amended) The method of claim 570, further comprising controlling a temperature within at least a majority of the part of the formation, wherein the pressure is controlled as a function of temperature, ~~or the temperature is controlled as a function of pressure.~~

580. (amended) The method of claim 570, further comprising controlling the heat such that an average heating rate of the part of the formation is less than about 1 °C per day in a pyrolysis temperature range from about 270 °C to about 400 °C.

581. (amended) The method of claim 570, wherein providing heat from the one or more heaters to at least the portion of formation comprises:

heating a selected volume (V) of the hydrocarbon containing formation from the one or more heaters, wherein the formation has an average heat capacity (C_v), and wherein the heating pyrolyzes at least some hydrocarbons within the selected volume of the formation; and

wherein heating energy/day (Pwr) provided to the selected volume is equal to or less than $h*V*C_v*\rho_B$, wherein ρ_B is formation bulk density, and wherein an average heating rate (h) of the selected volume is about 10 °C/day.

583. (amended) The method of claim 570, wherein providing heat from the one or more heaters comprises heating the part of the formation such that a thermal conductivity of at least a portion of the part of the formation is greater than about 0.5 W/(m °C).

595. (amended) The method of claim 570, wherein the produced mixture comprises a non-condensable component, wherein the non-condensable component comprises molecular hydrogen, wherein the molecular hydrogen is greater than about 10 % by volume of the non-condensable component, and wherein the molecular hydrogen is less than about 80 % by volume of the non-condensable component at 25 °C and one atmosphere absolute pressure.

601. (amended) The method of claim 570, further comprising controlling formation conditions, wherein controlling formation conditions comprises recirculating a portion of hydrogen from the mixture into the formation.

602. (amended) The method of claim 570, further comprising:

providing hydrogen (H_2) to the part of the formation to hydrogenate hydrocarbons within the part of the formation; and

Sub DH7 C12 ~~heating a portion of the part of the formation with heat from hydrogenation.~~

Sub B7 604. (amended) The method of claim 570, wherein allowing the heat to transfer comprises increasing a permeability of a majority of the ~~part~~ of the formation to greater than about 100 millidarcy.

C13 605. (amended) The method of claim 570, wherein allowing the heat to transfer comprises substantially uniformly increasing a permeability of a majority of the part of the formation.

Sub F7 ~~607. (amended)~~ The method of claim 570, wherein producing the mixture comprises producing the mixture in a production well, and wherein at least about 7 heaters are disposed in the ~~formation for~~ each production well.

Sub D16 C14 608. (amended) The method of claim 570, further comprising providing heat from ~~three or~~ more heaters to at least a portion of the formation, wherein three or more ~~of~~ the heaters are located in the formation in a unit of heaters, and wherein the ~~unit~~ of heaters comprises a triangular pattern.

609. (amended) The method of claim 570, further comprising providing heat from three or more heaters to at least a portion of the formation, wherein three or more of the heaters are located in the formation in a unit of heaters, wherein the unit of heaters comprises a triangular pattern, and wherein a plurality of the units are repeated over an area of the formation to form a repetitive pattern of units.

Sub D17 C15 623. (amended) A method of treating a hydrocarbon containing formation in situ, comprising:

providing heat from one or more heaters to at least a portion of the formation;

allowing the heat to transfer from the ~~one~~ or more heaters to a part of the formation to raise an average temperature within the part of the formation to, or above, a temperature that will pyrolyze hydrocarbons within the part of the formation;

~~producing a mixture from the formation; and~~

sub D17

controlling a weight percentage of olefins of the produced mixture to be less than about 20 % by weight by controlling average pressure and average temperature in the part of the formation such that the average pressure in the part of the formation is greater than the pressure (p) set forth in the following equation for an assessed average temperature (T) in the part of the formation:

C15

$$p = e^{[-57000/T + 83]}$$

where p is measured in psia and T is measured in Kelvin.

sub D18

~~665. (amended) A method of treating a hydrocarbon containing formation in situ~~, comprising:

providing heat from one or more heaters to at least a portion of the formation;

allowing the heat to transfer from the one or more heaters to a part of the formation to raise an average temperature within the part of the formation to, or above, a temperature that will

C16

pyrolyze hydrocarbons within the part of the formation;

producing a mixture from the formation; and

controlling hydrocarbons having carbon numbers greater than 25 of the produced mixture to be less than about 25 % by weight by controlling average pressure and average temperature in the part of the formation such that the average pressure in the part of the formation is greater than the pressure (p) set forth in the following equation for an assessed average temperature (T) in the part of the formation:

$$p = e^{[-14000/T + 25]}$$

where p is measured in psia and T is measured in Kelvin.

sub D19

~~668.~~ (amended) The method of claim 665, wherein the one or more heaters comprise at least two heaters, and wherein superposition of heat from at least the two heaters pyrolyzes at least some hydrocarbons within the part of the formation.

C17

669. (amended) The method of claim 665, wherein at least one of the one or more heaters comprises an electrical heater.

670. (amended) The method of claim 665, wherein at least one of the one or more heaters comprises a surface burner.

671. (amended) The method of claim 665, wherein at least one of the one or more heaters comprises a flameless distributed combustor.

672. (amended) The method of claim 665, wherein at least one of the one or more heaters comprises a natural distributed combustor.

673. (amended) The method of claim 665, further comprising controlling a temperature within at least a majority of the part of the formation, wherein the pressure is controlled as a function of temperature, or the temperature is controlled as a function of pressure.

674. (amended) The method of claim 673, wherein controlling the temperature comprises maintaining a temperature within the part of the formation within a pyrolysis temperature range from about 270 °C to about 400 °C.

675. (amended) The method of claim 665, further comprising controlling the heat such that an average heating rate of the part of the formation is less than about 1 °C per day in a pyrolysis temperature range from about 270 °C to about 400 °C.

676. (amended) The method of claim 665, wherein providing heat from the one or more heaters to at least the portion of formation comprises:

heating a selected volume (V) of the hydrocarbon containing formation from the one or more heaters, wherein the formation has an average heat capacity (C_v), and wherein the heating pyrolyzes at least some hydrocarbons within the selected volume of the formation; and

wherein heating energy/day (Pwr) provided to the selected volume is equal to or less than $h*V*C_v*\rho_B$, wherein ρ_B is formation bulk density, and wherein an average heating rate (h) of the selected volume is about 10 °C/day.

Subdat C18

678. (amended) The method of claim 665, wherein providing heat from the one or more heaters comprises heating the part of the formation such that a thermal conductivity of at least a portion of the part of the formation is greater than about 0.5 W/(m °C).

Subdat C19

690. (amended) The method of claim 665, wherein the produced mixture comprises a non-condensable component, wherein the non-condensable component comprises molecular hydrogen, wherein the molecular hydrogen is greater than about 10 % by volume of the non-condensable component, and wherein the molecular hydrogen is less than about 80 % by volume of the non-condensable component at 25 °C and one atmosphere absolute pressure.

Subdat C20

696. (amended) The method of claim 665, further comprising:

providing hydrogen (H_2) to the part of the formation to hydrogenate hydrocarbons within the part of the formation; and

heating a portion of the part of the formation with heat from hydrogenation.

Subdat C21

698. (amended) The method of claim 665, wherein allowing the heat to transfer comprises increasing a permeability of a majority of the part of the formation to greater than about 100 millidarcy.

699. (amended) The method of claim 665, wherein allowing the heat to transfer comprises substantially uniformly increasing a permeability of a majority of the part of the formation.

C22

701. (amended) The method of claim 665, wherein producing the mixture comprises producing the mixture in a production well, and wherein at least about 7 heaters are disposed in the formation for each production well.

Subdat C23

702. (amended) The method of claim 665, further comprising providing heat from three or more heaters to at least a portion of the formation, wherein three or more of the heaters are located in the formation in a unit of heaters, and wherein the unit of heaters comprises a triangular pattern.

703. (amended) The method of claim 665, further comprising providing heat from three or more heaters to at least a portion of the formation, wherein three or more of the heaters are located in the formation in a unit of heaters, wherein the unit of heaters comprises a triangular pattern, and wherein a plurality of the units are repeated over an area of the formation to form a repetitive pattern of units.

704. (amended) A method of treating a hydrocarbon containing formation in situ, comprising:

providing heat from one or more heaters to at least a portion of the formation;

allowing the heat to transfer from the one or more heaters to a part of the formation to raise an average temperature within the part of the formation to, or above, a temperature that will pyrolyze hydrocarbons within the part of the formation;

producing a mixture from the formation; and

controlling an atomic hydrogen to carbon ratio of the produced mixture to be greater than about 1.7 by controlling average pressure and average temperature in the part of the formation such that the average pressure in the part of the formation is greater than the pressure (p) set forth in the following equation for an assessed average temperature (T) in the part of the formation:

$$p = e^{[-38000/T + 61]}$$

where p is measured in psia and T is measured in Kelvin.

5396. (amended) The method of claim 567, wherein at least about 20 heaters are disposed in the formation for each production well.

5397. (amended) The method of claim 607, wherein at least about 20 heaters are disposed in the formation for each production well.

5398. (amended) The method of claim 701, wherein at least about 20 heaters are disposed in the formation for each production well.

Response To Office Action Mailed November 15, 2002

A. Pending Claims

Claims 531-610, 623-625, 665-706, and 5396-5398 are pending in the case. (Claims 5396-5398 were submitted with Preliminary Amendment mailed September 29, 2001, and depend on claims 567, 607, and 701, respectively.) Claims 745-784 and 5399 have been cancelled. Claims 531-539, 541, 554, 561, 562, 564, 565, 567-570, 573-581, 583, 595, 601, 602, 604, 605, 607-609, 623, 665, 668-676, 678, 690, 696, 698, 699, 701-704, and 5396-5398 have been amended.

B. Election/Restrictions

Applicant hereby elects the claims of Group I, namely claims 531-610, 623-625, 665-706, and 5396-5398, drawn to a method of heating a hydrocarbon formation where in the pressure is controlled as a function of temperature or the temperature is controlled by a function of pressure, including the use of specific or exemplary pressure-temperature relationships, without traverse. Applicant believes that the currently pending claims are directed to the elected subject matter. Applicant reserves the right to file divisional applications capturing the subject matter of the non-elected species.

C. Election of Species

In item 5 of the Office Action, the Examiner states: "Applicant is required under 35 U.S.C. 121 to elect a single disclosed species for prosecution on the merits to which the claims shall be restricted if no generic claim is finally held to be allowable." Applicant elects the species described in claims 570-609, drawn to a method of heating a hydrocarbon containing formation wherein the API gravity of a produced mixture is greater than 25° API by controlling the average pressure and temperature in the formation based on an exemplary pressure/temperature relationship or formula, without traverse. Applicant reserves the right for

consideration of claims to additional species written in dependent form upon allowance of a generic claim.

In item 6 of the Office Action, the Examiner states: "Applicant is required under 35 U.S.C. 121 to elect a single disclosed species for prosecution on the merits to which the claims shall be restricted if no generic claim is finally held to be allowable." Applicant elects the species of heater described at least in claims 537, 578, and 672, without traverse. The generic name of the elected species is: "natural distributed combustor." Natural distributed combustors are shown at least in figures 10-13. Applicant reserves the right for consideration of claims to additional species written in dependent form upon allowance of a generic claim.

D. Conclusion

Applicant believes no fees are due in filing of this document. If any extension of time is required, Applicant hereby requests the appropriate extension of time. If any fees are due, please charge those fees to Conley, Rose & Tayon, P.C. Deposit Account Number 50-1505/5659-08100/EBM.

Respectfully submitted,

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